Digestion Experiments.

TIMOTHY HAY.
TIMOTHY HAY WITH COTTON-SEED MEAL.
CRAB GRASS HAY.

Pasteurization of Milk.

ISSUED BY
THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
RALEIGH, N. C.

BULLETIN NO. 148

JUNE 8, 1898

484

Publications will be sent to any address in North Carolina upon application.

NORTH CAROLINA COLLEGE OF AGRICULTURE AND MECHANIC ARTS,

RALEIGH, N. C.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

BOARD OF TRUSTEES.

J. C. L. HARRIS, *President*, Raleigh.

L. C. EDWARDS.....Oxford.	J. R. CHAMBERLAIN.....Raleigh.
J. W. HARDEN, JR.....Raleigh.	S. L. CROWDER.....Halifax.
MATT MOORE.....Warsaw.	.....
J. Z. WALLER.....Burlington.	.....
H. E. BONITZ.....Wilmington.	.....
J. J. BRITT.....Bakersville	.....
ALEX. Q. HOLLADAY.....Raleigh.	.....

STATION COUNCIL.

ALEX. Q. HOLLADAY, LL. D., President of the College.

W. A. WITHERS, A. M.....Professor of Chemistry.
F. E. EMERY, M. S.....Professor of Agriculture.
W. F. MASSEY, C. E.....Professor of Horticulture.

EXPERIMENT STATION STAFF.

W. A. WITHERS., A. M, Acting Director.

W. A. WITHERS, A. M.....State Chemist.
F. E. EMERY, M. S.....Agriculturist.
W. F. MASSEY, C. E.....Horticulturist.
C. B. WILLIAMS, M. S.....Assistant Chemist.
H. K. MILLER, M. S.....Assistant Chemist.
C. D. HARRIS, B. S.....Assistant Chemist.
A. W. BLAIR, A. M.....Assistant Chemist.
J. A. BIZZELL, B. S.....Assistant Chemist.
F. G. KELLY.....Assistant Chemist.
G. S. FRAPS, B. S.....Assistant Chemist.
ALEX. RHODES (Southern Pines).....Assistant Horticulturist.
C. W. HYAMS.....Assistant Botanist.
J. M. JOHNSON, M. S.....Assistant Agriculturist.
F. E. HEGE.....Poultryman.
B. S. SKINNER.....Superintendent of Farm.
J. M. FIX.....Secretary.
H. E. KING.....Chief Clerk.
C. M. HUGHES, B. E.....Clerk.
MISS M. S. BIRDSONG.....Stenographer.
MRS. L. V. DARBY.....Stenographer.

The Director's office is in the main building of the College. Telephone No. 135 C. The street cars pass within one hundred yards of the College building.

The Station is glad to receive any inquiries on agricultural subjects. *Address all communications to the Agricultural Experiment Station, and not to individuals.* They will be referred to the members of the Station staff most competent to answer them.

DIGESTION EXPERIMENTS.

F. E. EMERY, Agriculturist.
B. W. KILGORE, Assistant Chemist.

HAY ALONE, AND IN RATIONS WITH COTTON-SEED MEAL.

Previously reported digestion work* has been done with cotton-seed products, ensilage, and rations made from them and on various other forage plants. It seemed desirable to digest Timothy hay, which sells at a high price on the markets of North Carolina cities, and also the native Crab grass hay, and rations of these hays with cotton-seed meal. In the rations of cotton-seed hulls with cotton-seed meal, and of corn silage with cotton-seed meal, there has been an increase of the digestible carbohydrates so much greater than the loss of digestible protein that it should create an additional incentive to feeders to feed well in order to secure this increased amount of digestible food from the coarse fodders, cotton-seed hulls, corn silage, etc., which they would lose if the meal were not added in the ration, but their animals forced to subsist on the coarse food alone, or with inadequate amounts of meal added to it to secure the gain from increased digestibility. One of the questions on which information was sought was whether the digestibility of these hays would follow the same course with relatively increasing amounts of cotton-seed meal fed in rations with each hay that has been found with the other coarse fodders used in previously reported experiments. In this respect there is little or no correspondence between those fodders and the Timothy hay used in these experiments. The hay was less digestible with cotton-seed meal than without it. The composition of foods used in the experiments hereinafter reported are shown in Table I, together with the composition of waste and solid excrement for all the experiments.

The feeding for these experiments was mostly done by R. E. L. Crenshaw, under the immediate direction of the Agriculturist. Collecting was done by him, assisted by Assistant Horticulturist, A. Rhodes, during some absences of the Agriculturist. The analyses were made by Messrs. F. B. Carpenter, C. B. Williams and H. K. Miller, of the Chemical Division under the direction of Mr. Kilgore.

These experiments were all made with young sheep purchased

*Bulletins 80c, 87d, 97 and 118.

for the purpose. Two stalls were prepared for collections, so they could be opened out to give sheep room to move about during the preliminary feeding and the sheep comfortably confined for saving excrement during the collection periods. Two other stalls of about equal size were prepared, and two sheep were placed in these and fed the same as those which were being used for the digestion experiments. This was to provide a safeguard for the experiment should any accident befall the other sheep in any period. No such trouble occurred, and at the end, sheep Nos. 3 and 4 were used to duplicate the digestions made by sheep Nos. 1 and 2 on crabgrass hay in order not only to have an average of four animals for the digestibility of the hay, but as a means of comparison as to the relative digestive powers between the sheep.

These sheep when first stabled were fed on corn silage, morning and noon, with mixed hay at night for a few days; then they were fed the hay to be digested.

The time of year and close confinement during all the hot weather of mid-summer, with no ill effects therefrom, is worthy of note. All four of the animals were turned out in good health after nearly ten months of confinement.

(1.) Digestion of Timothy Hay by Sheep Nos. 1 and 2.

Timothy hay fed: 2¼ pounds per day to each sheep.

Total period on Timothy hay alone 36 days. The sheep were separated and fed individually 24 days. Collection period began July 29th; the first day's collections were not completed and were discarded. Sheep No. 1 was retained an extra day because of a small loss on another occasion for which a day's collection was discarded; the period ended August 9th for sheep No. 2 and August 10th for sheep No. 1. Feces were collected 12 and 11 days. Two days lost by sheep No. 1, and one day by sheep No. 2. Feed and waste was for 12 and 11 days.

	No. 1.	No. 2.	No. 3.	No. 4.
The sheep weighed when these collections began,	69	69 n'rly.	47 n'rly.	65
Average of three weights next after harnesses removed at close of collections	71	70	50	66

The weights were maintained and sheep gained some during the period.

All the analyses of hay, etc., for this and following experiments will be found in Table I, appended to this report. The coefficients of digestibility as worked out in Table No. II, are for dry matter, 51.2 per cent.; ash, 23 per cent.; protein, 33.5 per cent.; fat, 17.6 per cent.; nitrogen-free extract, 58 per cent.; crude fibre, 48 per cent.

Nutritive ratio, 1: 2[illegible].1.

(2). DIGESTION OF TIMOTHY HAY AND COTTON-SEED MEAL BY SHEEP NOS. 1 AND 2.

Date of Experiment, August, 1895.

Rations fed: 36 ounces hay, 2¼ ounces cotton-seed meal daily to each sheep. The rations were consumed in the ratio of 15.15 to 1 when calculated on dry matter. Total period 19 days. Feces were collected during the last 10 days.

	No. 1.	No. 2.	No. 3.	No. 4.
Weights of sheep in early part of this period...	71	70	50	66
Weights of sheep Nos. 3 and 4 at close of this period.....			50⅓	66
Nos. 1 and 2 three weights next succeeding collections	74	68⅓		

The weights were maintained. Analyses are included in Table No. 1. The coefficients of digestibility as worked out in Table No. III, are:

	Dry Matter, per cent.	Ash, per cent.	Protein (N×6.25), per cent.	Fat, per cent.	N-Free Extract, per cent.	Crude Fibre, per cent.
For the Ration..	55.3	22.8	50.7	50.1	62.1	48.9
For the Hay....	54.1	22.4	28.4	36.2	62.2	48.9

Nutritive ratio of ration, 1: 12.4; of hay in ration, 1: 33.2.

(3). DIGESTION OF A SECOND LOT OF TIMOTHY HAY WITH COTTON-SEED MEAL, BY SHEEP NOS. 1 AND 2.

Date of Experiment, August and September, 1895.

Rations fed: 33 ounces per day of hay and 2¾ ounces cotton-seed meal.

Total period 21 days; feces were collected during the last 10 days.

	No. 1.	No. 2.	No. 3.	No. 4.
Weights of sheep early part of period Nos. 1 and 2 and end of last period as above	74	68⅓	50⅓	66
Weights of sheep Nos. 3 and 4 at end of period, Nos. 1 and 2 early part of next.....	81⅔	71	50⅓	71½

Weights of sheep Nos. 1 and 4 were somewhat advanced by more than average amounts of water drank previous to weighing. Slight gain probable.

All analyses are given in Table No. I. Coefficients of digestibility as worked out in Table No. IX, are:

	Dry Matter, per cent.	Ash, per cent.	Protein (N×6.25), per cent.	Fat, per cent.	N-Free Extract, per cent.	Crude Fibre, per cent.
For the Ration..	53.6	21.2	24.9	64.1	59.9	47.2
For the Hay....	52.0	19.9	32.4	53.4	59.8	47.2

Nutritive ratio of ration, 1: 9.9; of hay, 1: 26.3.

(4). DIGESTION OF SECOND LOT TIMOTHY HAY AND COTTON-SEED MEAL BY SHEEP NOS. 1 AND 2.

Date of Experiment, September and October, 1895.

Rations fed: 32 ounces hay, 4 ounces cotton-seed meal daily to each sheep. Total period, 21 days; collection of feces was made during the last 10 days.

	No. 1.	No. 2.	No. 3.	No. 4.
Weights of sheep, taken as above	81⅔	71	50⅓	71½
At end of period, taken as above	76	69⅓	51	70⅔

In consideration of effect of water on weights of sheep, as noted above, we consider the weight fairly maintained. Nine weights immediately following the three which averaged 81⅔, for No. 1 averaged 77 pounds, while the two days before harness was put on he weighed less than this amount, evidently because of drinking less water the evenings before being weighed. All analyses are given in Table No. I. Coefficients of digestibility as worked out in Table No. V, are:

	Dry Matter, per cent.	Ash, per cent.	Protein, (N × 6.25), per cent.	Fat, per cent.	N. Free Extract, per cent.	Crude Fiber, per cent.
For the Ration..	48.9	10.4	54.9	61.5	55.0	41.7
For the Hay....	45.8	6.2	20.8	43.6	54.5	41.6

Nutritive ratio of ration, 1: 7.7; of hay, 1: 37.

(5). DIGESTION OF TIMOTHY HAY AND COTTON-SEED MEAL BY SHEEP NOS. 1 AND 2.

Date of Experiment, October and November, 1895.

Rations fed: 26 ounces Timothy hay and 6½ ounces cotton-seed meal per day to each of 3 sheep, No. 3, 16 and 4 ounces respectively. Total period, 26 days. Collection period, 15 days. First 5 discarded because sheep wasted a little hay under feet. Collections were saved the last 10 days.

	No. 1.	No. 2.	No. 3.	No. 4.
Weights of sheep as before	76	69⅓	51	70⅔
Weights of Nos. 3 and 4 at end of period, Nos. 1 and 2 beginning of next period	74⅙	66½	50⅙	68⅓

Weights *nearly* maintained, if not quite, except for No. 1 some loss. Weights affected by sheep Nos. 1 and 4 taking less water than usual on evenings before being weighed. All analyses are given in Table No. 1. Coefficients of digestibility as worked out in Table No. VI, are:

	Dry Matter per cent.	Ash, per cent.	Protien, (N×6.25), per cent.	Fat, per cent	N-Free Extract, per cent.	Crude Fiber, per cent.
For the Ration..	51.5	*5.7	60.6	74.7	57.3	42.7
For the Hay....	45.8	....	3.9	55.4	56.7	42.6

*Only for sheep No. 2. Nutritive ratio of ration, 1: 5.3; of hay, 1: 204.

(6). Digestion of Timothy Hay and Cotton Seed Meal by Sheep Nos. 1 and 2.

Date of Experiment, November, 1895.

Rations fed each of three sheep: 20 ounces hay and 10 ounces cotton-seed meal per day. Sheep No. 3, 14 ounces hay and 7 ounces meal. Total period, 20 days; collection of feces occurred during the last 10 days.

	No. 1.	No. 2.	No. 3.	No. 4.
Weights of sheep, taken as above	74⅙	66½	50⅙	68⅓
Weights of sheep at close of period, taken as above	73	67⅔	50 5-6	67 5-6

Weights maintained. Weight of No. 1, affected as before, by water drank. Ten weights during preliminary period averaged 72.45 pounds. A loss occurred during last collection, or this ration was not quite sufficient to maintain his weight. All analyses are given in Table No. 1. Coefficients of digestibility, as worked out in Table No. VII, are:

	Dry Matter, per cent.	Ash., per cent.	Protein (N×6.25), per cent.	Fat, per cent.	N-Free Extract, per cent.	Crude Fiber, per cent.
For the Ration..	59.1	14.7	71.4	84.9	66.9	39.5
For the Hay....	52.0	6.6	6.3	71.7	68.4	38.9

Nutritive ratio of ration, 1: 3.5; of hay, 1: 74.8.

(7). Digestion of Timothy Hay and Cotton-Seed Meal by Sheep Nos. 1 and 2.

Date of Experiment, November and December, 1896.

Daily rations fed Sheep Nos. 1 and 2: 18 ounces each, hay and meal; No. 3, 13 ounces each, hay and meal; No. 4, 16 ounces each, hay and meal. Total period 24 days; collection of feces was made during last 10 days.

	No. 1.	No. 2.	No. 3.	No. 4.
Weights of sheep, as above, at beginning of period	73	67⅔	50 5-6	67 5-6
Weights of sheep, as above, at end of period	77⅓	73 5-6	53	71 5-6

A decided gain of weight occurred during the period. All analyses are given in Table No. I. Coefficients of digestibility, as worked out in Table No. VIII, are:

	Dry Matter, per cent.	Ash, per cent.	Protein (N×6.25), per cent.	Fat., per cent.	N-Free Extract, per cent.	Crude Fiber, per cent.
For the Ration..	61.4	27.4	75.6	88.6	68.8	27.8
For the Hay...	49.2	20.8	.....	83.0	73.0	24.8

Nutritive ratio of ration, 1: 2.34.

(8). Digestion of Second Lot Timothy Hay Alone by Sheep Nos. 1 and 2.

Date of Experiment, December, 1895, and January, 1896.

Rations fed: 36 ounces of Timothy hay daily to sheep Nos. 1 and 2, 32 ounces to sheep No. 4, and 26 ounces to Sheep No. 3. Total period 21 days; collection of feces was made during the last 10 days.

	No. 1.	No. 2.	No. 3.	No. 4.
Weights of sheep, taken as above, at the beginning of the period	77⅓	73 5-6	53	71 5-6
Weights of sheep at close of period, taken as before	73 5-6	72½	50⅔	70 5-6

Weights not maintained as at beginning of period. All analyses are given in Table No. I. Coefficient of digestibility as worked out in Table No. IX, are: Dry matter, 54.2 per cent.; Ash., 28.7 per cent; Protein (N × 6.25), 35.1 per cent; Fat (Ether extract), 49.2 per cent.; N-free extract, 66.1 per cent.; Crude Fiber, 42.2 per cent.

Nutritive ratio of hay, 1: 25.3.

(9). Digestion of Timothy Hay and Undecarticated Sunflower Seed Meal Attempted.

Date of Experiment, January, 1896.

Rations offered: Sheep Nos. 1 and 2, 32 ounces Timothy hay and 2 ounces Sunflower-seed meal.
Sheep No. 3, 24 ounces Timothy hay and 1½ ounces Sunflower-seed meal.
Sheep No. 4, 26 ounces Timothy hay and 1¾ ounces Sunflower-seed meal.

Total period 22 days, divided as follows: Meal offered the second and eight succeeding days and none consumed. Meal offered two days and hay withheld. No meal consumed during either portion of this period. Hay fed alone rest of period. The seed was raised in 1894 by several parties and was, after some delays, gathered together and put through the cotton oil mill to express the oil. The meal fed was probably too old or perhaps the seed was damaged in curing. At least sheep would not eat it.

(10). Digestion of Crabgrass Hay by 4 Sheep, Nos. 1 and 2.

Date of Experiment, April, 1896.

Rations fed: Sheep No. 1, 32 ounces; Sheep No. 2, 36 ounces; Sheep No. 3, 26 ounces; Sheep No. 4, 26 ounces per day. Total period, 30 days. For first experiment, 20 days; second experiment, 10 days more for collection period for Sheep Nos. 3 and 4.

	Weights of Sheep No. 1 and No. 2.		No. 3 and No. 4.	
April 1–3, average of 3 weights	83	84⅔	60⅔	77⅔
April 20–21, average of 2 weights	76½	82½	....	....
April 18–19–20, average of weight	....	....	62⅙	76⅔
April 28–29–30, average of weights	69⅔*	72½*	....	....

Weights of two sheep not maintained, and the other two about

*Sheared April 21; fleece 3⅛ and 2 9-16 lbs. respectively.

maintained. All analyses are given in Table No. 1. Coefficients of digestibility as worked out in Table No. X, are:

	Dry Matter, per cent.	Ash, per cent.	Protein, (N×6.25), per cent.	Fat (Ether Extract), per cent.	N-Free Extract, per cent.	Crude Fiber, per cent.
Average for 4 sheep .	50.7	44.4	....	42.6	51.0	58.4

Nutritive ratio, 1: 99.5.

TABLE A.—Digestibility of Timothy Hay Fed Alone and with Different Proportions of Cotton-seed Meal.

Number of Experiment		Total Dry Matter.	Ash.	Protein (N×6.25).	Fat (Ether Extract).	N-Free Extract.	Crude Fiber.
1	Average per cent. digested from Timothy hay when fed alone..	51.2	23.0	33.5	17.6	58.0	48.0
2	Average per cent. digested from Timothy hay fed with cotton-seed meal when fed in proportion of 16 hay to 1 meal with some waste, assumed to be all hay, where the ratio eaten was 15.15 to 1 on dry matter..........	54.1	22.4	28.4	36.2	62.2	48.9
3	Average per cent. digested from second lot of Timothy hay fed with cotton-seed meal in the proportion of 12 to 1 with dry matter consumed at the rate of 11.7 in hay to 1 in meal...	52.0	19.9	32.4	53.4	59.8	47.2
4	Average per cent. digested from Timothy hay fed with cotton-seed meal in the proportion of 8 to 1 with dry matter consumed at the rate of 7.77 to 1 in hay and meal.......	45.8	6.2	20.8	43.6	54.5	41.6
5	Average per cent. digested from Timothy hay fed with cotton-seed meal in the proportion of 4 hay to 1 of meal with dry matter consumed at the rate of 3.88 in hay to 1 in meal..	45.8	....	3.9	55.4	56.7	42.6
6	Average per cent. digested from Timothy hay fed with cotton-seed meal in the proportion of 2 hay to 1 meal with dry matter consumed at the rate of 1.8 in hay to 1 in meal....	52.0	6.6	6.3	71.7	68.4	38.9
7	Average per cent. digested from Timothy hay fed with cotton-seed meal in the proportion of 1 of hay to 1 of meal with dry matter consumed at the rate of .98 in hay to 1 in meal............	49.2	20.8	....	83.00	73.0	24.8
	Average per cent. digested from second lot of Timothy hay when fed alone..............	54.2	28.7	....	49.2	66.1	42.2
	Average per cent. digested from two lots Timothy hay when fed alone..............	52.7	25.9	34.3	33.4	62.10	45.1
	Average per cent. digested from crabgrass hay when fed alone. Average of four trials with four different sheep..	50.7	4.44	.....	42.6	51.	58.4

TABLE I.—Showing Percentage Composition of Foods. Waste and Solid Excrement.

Analysis No.		Water.	Dry Matter.	DRY MATTER CONTAINS					
				Ash.	Protein (N×6.25).	Albuminoids (Alb. N ×6.25).	Fat (Ether Extract).	N-Free Extract.	Crude Fiber.
656	Timothy hay	9.35	90.65	3.86	5.66	4.42	2.11	55.92	32.45
663	Waste, timothy hay, Sheep No. 1	12.48	87.50	5.59	5.71	5.13	2.62	53.02	33.06
664	Waste, timothy hay, Sheep No. 2	12.20	87.80	5.80	6.67	6.21	2.41	52.06	33.06
661	Solid excrement, Sheep No. 1	66.90	33.10	6 15	8.08	6.94	3.46	48.65	33.66
662	Solid excrement, Sheep No. 2	67.16	32.84	5.51	7.52	7.46	3.53	48.06	35 38
660	Cotton-seed meal	9.76	90.24	6.93	47.79	47.17	10.48	29 30	5.50
671	Waste, Sheep No. 1	15.30	84.70	7.75	7.58	5.66	2.07	48.49	34.11
672	Waste, Sheep No. 2	13.35	86.65	4.81	5.91	5.72	2.23	52.50	34.55
669	Solid excrement, Sheep No. 1	69.90	30.10	6.37	9.02	8.06	3.12	47.18	34.31
670	Solid excrement, Sheep No. 2	72.49	27.51	6.97	9.39	8.54	2.81	45.59	35.24
675	Waste, Sheep No. 1, third experiment	17.56	82.45	5.44	10.06	8.78	2.59	49.28	32.63
676	Waste, Sheep No. 2, third experiment	14.55	85.45	4.92	7.74	6.33	1.99	50.51	34.84
673	Solid excrement, Sheep No. 1, third experiment	69.02	30.98	7.59	8.92	8.11	2.27	44.73	36.49
674	Solid excrement, Sheep No. 2, third experiment	76.21	23.79	8.46	9.05	8.20	2.07	43.48	36.94
677	Timothy hay fed, third and later experiments	10.88	89.12	4.56	5.99	5.26	2.14	52.79	34.52
678	Waste, Sheep No. 1, fourth experiment	20.29	79.71	9.50	17.82	11.60	3 46	42.03	27.19
679	Waste, Sheep No. 2, fourth experiment	11.83	88.17	5.50	8.00	6.56	2.47	50.53	33.50
680	Solid excrement, Sheep No. 1, fourth experiment	71.94	28.06	8.42	9.47	8.31	2.35	44.08	35.68
681	Solid excrement, Sheep No. 2, fourth experiment	77.81	22.19	8.43	9.40	8 00	2.30	44.30	35.57
685	Waste, Sheep No. 1, fif h experiment	25.67	74.33	24.35	31.25	28.50	6.88	26.64	10.85
686	Waste, Sheep No. 2, fifth experiment	15.04	84.96	4.98	7.91	7.41	2.65	53.19	31.27
683	Solid excrement, Sheep No. 1, fifth experiment	77.39	23.61	10.60	11.94	10.32	1.64	42.05	33.77
684	Solid excrement, Sheep No. 2, fifth experiment	79.59	20.41	9.78	11.69	10.72	2.37	42.36	33.80
689	Waste, Sheep No. 1, sixth experiment	20.00	80.00	11.07	35 78	32.41	8.11	31.04	14.00
690	Waste, Sheep No. 2, sixth experiment	9.53	90.47	11.02	37.50	34.02	8.36	30.51	12.61
687	Solid excrement, Sheep No. 1, sixth experiment	72.18	27.82	11.06	14.28	12.75	1.91	36.40	36.35
688	Solid excrement, Sheep No. 2, sixth experiment	77.78	22.22	11.20	13.69	11.94	1.75	36.31	37.05

TAALE I.—Showing Percentage Composition of Foods, Waste and Solid Excrement.—Continued.

Analysis No.		Water.	Dry Matter.	DRY MATTER CONTAINS					
				Ash.	Protein (N×6.25).	Albuminoids (Alb. N ×6.25).	Fat (Ether Extract).	N-Free Extract.	Crude Fiber.
700	Hay waste, Sheep No. 1, seventh experiment.....	7.15	92.85	5.50	15.85	13.78	3.44	41.47	33.74
699	Meal waste, Sheep No. 1, seventh experiment.....	6.66	93.34	7.88	50.13	46.07	10.25	22.80	8.94
701	Waste, Sheep No. 2, seventh experiment.	20.39	79.61	10.72	43.79	40.03	7.89	24.13	13.47
697	Solid excrement, Sheep No. 1, seventh experiment....	65.78	34.22	11.05	17.44	14.69	1.82	31.05	38.64
698	Solid excrement, Sheep No. 2, seventh experiment.....	65.81	34.19	10.54	16.72	13.84	1.93	35.26	35.55
704	Waste, Sheep No. 1, eighth experiment.....	14.39	85.61	4.80	6.50	5.92	2.23	44.39	42.08
705	Waste, Sheep No 2, eighth experiment.....	12.30	87.70	4.65	5.78	5.13	3.49	45.14	40.94
702	Solid excrement, Sheep No. 1, eighth experiment	67.24	32.76	7.19	8.52	7.06	2.37	40.28	41.64
703	Solid excrement, Sheep No. 2, eighth experiment	73.65	26.35	6.93	8.35	7.44	2.26	39.62	42.84
706	Solid excrement, Sheep No. 1, ninth experiment.....	67.58	32.42	8.40	10.06	8.50	2.45	46.21	32.88
707	Solid excrement, Sheep No. 2, ninth experiment	81.16	18.84	9.10	10.06	9.06	2.46	44.25	34.13
708	Waste, crab-grass hay, Sheep No. 1, ninth experiment..	11.51	88.49	5.63	6.26	5.60	2.58	46.90	38.63
709	Waste, crab-grass hay, Sheep No. 2, ninth experiment..	11.11	88.89	5.00	5.16	4.47	2.17	46.35	41.32
710	Total solid excrement, Sheep No. 3, tenth experiment..	63.46	36.54	7.02	9.13	8.19	2.14	42.88	38.83
711	Total solid excrement, Sheep No. 4, tenth experiment..	61.28	38.72	7.26	10.28	9.56	2.25	47.24	32.97
712	Waste, crab-grass hay, Sheep No. 3, tenth experiment..	12.39	87.61	4.75	4.51	3.75	1.99	47.65	41.10
713	Waste, crab-grass hay, Sheep No. 4, tenth experiment..	10.99	89.01	5.97	6.29	5 44	2.47	44.34	40.93
715	Crab-grass hay, first and second experiments.....	13.02	86.98	6.41	5.00	4.03	2.18	45.42	40.99

TABLE II.—Showing Nutrients Consumed and Excreted in Grams with Percentage Digested.

SHEEP No. 1.

No. of Analysis.		Total Amount.	Dry Matter.	DRY MATTER CONTAINS					
				Ash.	Protein (N×6.25).	Albuminoids (Alb. N × 6.25).	Fat (Ether Extract).	N-free Extract.	Crude Fiber.
656	Timothy hay fed in 12 days	12247.2	11102.1	428.54	628.38	490.71	234.25	6208.29	3602.63
663	Waste, timothy hay, 12 days	1407.5	1231.8	68.86	70.34	63.19	32.27	653.10	407.23
	Total consumed	10839.7	9870.3	359.68	558.04	427.52	201.98	5555.19	3195.40
661	Total solid excrement, 10 days	11401.0	3773.7	232.08	304.91	261.89	130.57	1835 91	1270.23
	Total excrement per day	1140.1	377.4	23.21	30.49	26 19	13.06	183.59	127.02
	Total digested per day		445.1	6.76	16.01	9.44	3.77	279.34	139.26
	Per cent. digested		54.12	22.56	34.43	26.49	22.40	60.34	52.30

SHEEP No. 2.

656	Timothy hay fed in 11 days	11226.6	10176.9	392.83	576.01	449.82	214.73	5690 92	3302.40
664	Waste, timothy hay in 11 days	788.	691.9	40 13	46.15	42.97	16.67	360.20	228.74
	Total consumed	10438.6	9485.0	352.70	529.86	406.85	198.06	5330.72	3073.66
	Consumed per day	948.96	862.27	32.06	48.17	36.99	18.01	484.61	279.42
762	Total solid excrements in 10 days	13564.	4454.4	245.44	334.97	332.30	157.24	2140.78	1575.97
	Solid excrement per day	1356.4	445.4	24.54	33.50	33.23	15.72	214.08	157.60
	Total digested per day		416.9	7.52	15.67	3.76	2.29	270 53	121.82
	Per cent. digested		48.35	23.46	32.53	10.16	12.72	55.82	43.60
	Mean of both animals		51.2	23.	33.5	18.3	17.6	58.	48.

Mean nutritive ratio of old timothy hay 1:26.1.

TABLE III.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

Second Experiment, Timothy Hay, 16 to Cotton-seed Meal 1.

SHEEP No. 1.

Analysis No.		Total Amount.	Total Dry Matter.	DRY MATTER CONTAINS					
				Ash.	Protein (N×6.25)	Albuminoids (Alb. N ×6.25)	Fat. (Ether Extract.)	N-free Extract.	Crude Fiber.
656	Timothy hay fed	10206.	9251.7	357.12	523.65	408.93	195.21	5173.55	3002.18
660	Cotton-seed meal fed	637.9	575.6	39.89	275.08	271.51	60.32	168.65	31.66
	Total fed	10843.9	9827.3	397.01	798.73	680.44	255.53	5342.20	3033.84
671	Waste	624.	528.5	40.96	40.06	29.91	10.94	256.27	180.27
	Total consumed	....	9298.8	356.05	758.67	650.53	244.59	5085.93	2853.57
669	Total solid excrement	13270.	3994.3	254.44	360.29	321.94	124.62	1884.51	1370.44
	Total digested	.....	5304.5	101.61	398.38	328.59	119.97	3201.42	1483.13
	Per cent. digested	....	57.04	28.54	52.51	50.51	49.05	62.95	51.97

SHEEP No. 2.

656	Timothy hay fed	10206.	9251.7	357.12	523.65	408.93	195.21	5173.55	3002.18
660	Cotton-seed meal fed	637.9	575.6	39.89	275.08	271.51	60.32	168.65	31.66
	Total fed	10843.9	9827.3	397.01	798.73	680.44	255.53	5342.20	3033 84
672	Waste	1726.	1495.6	71.94	88.39	85.55	33.35	785.19	516.73
	Total consumed	9117.9	8332.7	325.07	710.34	594.89	222.18	4557.01	2517.11
	Total solid excrement	14058.5	3867.5	269.56	363.16	330.28	108.68	1763.19	1362.91
	Total digested	.....	4465.2	55.51	347.18	264.61	113.50	2793.82	1154.20
	Per cent. digested	.....	53.59	17.08	48.88	44.48	51.09	61.31	45.85
	Mean per cent. of ration digested by two sheep	.....	55.3	22.8	50.7	47.5	50.1	62.1	48.9

Mean nutritive ratio of Timothy hay 16 to cotton-seed meal 1, 1:12.4.

TABLE IV.—Showing Nutrients Consumed and Execreted in Grams with Percentages Digested.
Third Experiment, Timothy Hay 12 to Cotton-seed Meal 1).

SHEEP No. 1.

Analysis No.		Dry Matter.	Total Dry Matter.	DRY MATTER CONTAINS. Ash.	Protein (N×6.25).	Albuminoids (Alb. N ×6.25)	Fat (Ether Extract).	N-Free Extract.	Crude Fiber.
677	Timothy hay fed	9355.5	8337.6	380.19	499.42	438.56	178.42	4401.42	2878.14
660	Cotton-seed meal	779.6	703.5	48.75	336.20	331.84	73.73	206.13	38.69
	Total fed	10135.1	9041.1	428.94	835.62	770.40	252.15	4607.55	2916.83
675	Waste	82.0	67.60	3.68	6.80	5.94	1.75	33.31	22.06
	Total consumed	10053.1	8973.5	425.26	828 82	764.46	250.40	4574.24	2894.77
673	Total solid excrement	12541.	3885.3	294.89	346.57	315.10	88.20	1737.89	1417.75
	Total digested	....	5088.2	130.37	482.25	449.36	162.20	2836.35	1477.02
	Per cent. digested	.....	56.70	30.66	58.19	58.78	64.78	62.01	51.02

Nutritive ratio of ration 1:9.8. SHEEP No. 2.

677	Timothy hay fed	9355.5	8337.6	380.19	499.42	438.56	178.42	4401.42	2878.14
660	Cotton-seed meal fed	779.6	703.5	48.75	366.20	331.84	73.73	206.13	38.69
	Total fed	10135.1	9041.10	428.94	835.62	770.40	252.15	4607.55	2916.83
676	Waste	100.	85.45	4.20	6.61	5.41	1.70	43.16	29.77
	Total consumed	10035.1	8955.65	424.74	829.01	764.99	250.45	4564.39	2887.06
674	Total solid excrement	18615.	4429.2	374.71	4c0.84	363.19	91.68	1925.82	1636.15
	Total digested	.....	4526.43	50.03	428.17	401.80	158.77	2638.57	1250.91
	Per cent. digested	.....	50.54	11.78	51.65	52.52	63.39	57.81	43.33
	Mean of both animals	.....	53.6	21.2	55.9	55.7	64.1	59.9	47.2

Ratio of ration, 1:10.0. Mean nutritive ration, hay 12 to meal 1, 1:9.9.

TABLE V.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

Fourth Experiment, Timothy Hay, 8 to Cotton-seed Meal 1.

SHEEP No. 1.

Analysis No.		Total Amount.	Total Dry Matter.	DRY MATTER CONTAINS.					
				Ash.	Protein (N × 6.25)	Albuminoids (Alb. N ×6.25)	Fat (Ether Extract).	N-free Extract.	Crude Fiber.
677	Timothy hay fed	9072.	8085.0	368.68	484.29	425.27	173.02	4268.07	2790.94
660	Cotton-seed meal fed	1134.	1023.3	70.91	489.04	482.69	107.24	299.83	56.28
	Total fed	10206.	9108.3	439.59	973.33	907.96	280.26	4567.90	2847.22
678	Waste	72.	57.4	5.45	10.23	6.66	1,99	24.13	15.61
	Total consumed		9050.9	434.14	963.10	901.30	278.27	4543.77	2831.61
680	Total solid excrement	15911.5	4465.0	375 95	422.84	371.04	104.93	1968.17	1593.11
	Total digested		4585.9	58.19	540.26	530.26	173.34	2575.60	1238.50
	Per cent. digested		50.67	13 40	56 10	58.83	62.29	56.68	43.73

Nutritive ratio of ration, 1:7.86.

SHEEP No. 2.

677	Timothy hay fed	9072.	8085.0	368.68	484.29	425.27	173.02	4268.07	2790.94
660	Cotton-seed meal fed	1134.	1023.3	70.91	489.04	482.69	107.24	299.83	56.28
	Total fed	10206.	9108.3	439.59	973.33	907.96	280.26	4567.90	2847.22
679	Waste	236.5	208.5	11.47	16.68	13.68	5.15	105.36	69.85
	Total consumed		8899.8	428.12	956.65	894.28	275.11	4462.54	2777.37
681	Total Solid excrement	21206.	4705.3	396.66	442.30	376.42	108.22	2084.45	1673.68
	Total digested		4194.5	31.46	514.35	517.86	166.89	2378.09	1103.69
	Per cent. digested		47.13	7.35	53.77	57.91	60.66	53.29	39.74
	Mean of both animals		48.9	10.4	54.9	58.4	61.5	55 0	41.7

Nutritive ratio of ration, 1:7.58. Mean nutritive ratio of ration of hay 8 to meal 1 on dry matter, 7.91 to 1, was 1:7.72.

TABLE No. VI.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

(Fifth Experiment, Timothy Hay 4 to Cotton-seed Meal 1. Collection Period October 26th to November 5th, 1895).

SHEEP No. 1.

No. of Analysis.		Total Amount.	Total Dry Matter.	DRY MATTER CONTAINS					
				Ash.	Protein (N×6.25).	Albuminoids (Alb. N × 6.25).	Fat (Ether Extract).	N-free Extract.	Crude Fiber.
677	Timothy hay fed	7371.	6569.0	299.55	393.48	345.53	140.58	3467.78	2267.62
660	Cotton-seed meal fed	1842.8	1662.9	115.24	794.70	784.39	174.27	487.23	91.46
	Total fed	9213.8	8231.9	414.79	1188.18	1129.92	314.85	3955.01	2359.08
685	Waste	33.0	24.5	5.97	7.66	6.98	1.69	6.53	2.66
	Total consumed		8207.4	408.82	1180.52	1122.94	313.16	3948.48	2356 42
683	Total solid excrement	16832.	3974.4	421.29	474.54	410.16	65.18	1671.24	1342.15
	Total digested		4233.0	12.47	705.98	712.78	247.98	2277 24	1014.27
	Per cent. digested		51.58		59.80	63.47	79.19	57.67	43.04

Nutritive ratio of ration 1: 5.54.

SHEEP No. 2.

677	Timothy hay fed	7371.	6569.0	299.55	393.48	345.53	140.58	3467.78	2267.62
660	Cotton-seed meal fed	1842.8	1662 9	115.24	794.70	784.39	174.27	487.23	91.46
	Total fed		8231.9	414.79	1188.18	1129.92	314.85	3955.01	2359.08
686	Waste	402.0	341.5	17.01	27.01	25.31	9.05	181.64	106.79
	Total consumed		7890.4	397.78	1161.17	1104.61	305.80	3773.37	2252.29
684	Total solid excrement	18799.	3836.9	375.25	448.53	411.32	90.93	1625.31	1296.87
	Total digested		4053.5	22.53	713.64	693.29	214.87	2148.06	955.42
	Per cent. digested		51.37	56.64	61.37	62.76	70.26	56.93	42.42
	Average per cent. digested		51.5	*5.7	60.59	63.12	74.73	57.30	42.73

*Only for Sheep No. 2.

Nutritive ratio 1: 5.10. Mean nutritive ratio of ration of hay 4 to meal 1, on dry matter 3.95 to 1, 1: 5.3.

TABLE VII.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

Sixth Experiment, Timothy Hay 2 to Cotton-seed Meal, 1 fed.

SHEEP No. 1.

No. of Analysis.		Total Amount.	Total Dry Matter.	DRY MATTER CONTAINS.					
				Ash.	Protein (N ×6.25).	Albuminoids (Alb. N ×6.25).	Fat (Ether Extract).	N-Free Extract.	Crude Fiber.
677	Timothy hay fed	5670.	5053.1	230.42	302.68	265.79	108.14	2667.53	1744.33
660	Cotton-seed meal fed	2835.	2558.3	177 29	1222.61	1206.75	268.11	749.58	140.71
	Total fed	8505.	7611.4	407.71	1525.29	1472.54	376.25	3417.11	1885.04
689	Waste	34.5	27.6	3.06	9.88	8.95	2.24	8.57	3.86
	Total consumed	8470.5	7583.8	404.65	1515.41	1463.59	374.01	3408.54	1881.18
687	Total solid excrement	10377.5	2887.0	319.30	412.26	368.09	55.14	1050.87	1049.42
	Total digested		4696.8	85.35	1103.15	1095.50	318.87	2357.67	831.76
	Per cent. digested		61.93	21.09	72.80	74.85	85.26	69.17	44.21

Nutritive ratio of ration, 1: 3.61.

SHEEP No. 2.

677	Timothy hay fed	5670.	5053.1	230.42	302.68	265.79	108.14	2667.53	1744.33
660	Cotton-seed meal fed	2835.	2558.3	177.29	1222.61	1206.75	268.11	749.58	140.71
	Total fed	8505.0	7611.4	407.71	1525.29	1472.54	376.25	3417.11	1885.04
690	Waste	26.5	24.0	2.64	9.00	8.16	2.01	7.32	3.03
	Total consumed	8478,5	7587.4	405.07	1516.29	1464.38	374.24	3409.79	1882.01
688	Total solid excrement	14934.5	3318.0	371.62	454.23	396.17	58.07	1204.77	1229.32
	Total digested		4269.4	33.45	1062.06	1068.21	316.17	2205.02	652.69
	Per cent. digested		56.27	8.26	70.04	72.95	84.48	64.67	34.68
	Average per cent. digested by two sheep		59.1	14.68	71.42	73.90	84.87	66.92	39.45

Nu tritive ratio of ration, 1: 3.43; Mean nutritive ratio of ration, 1: 3.5.

TABLE VIII.—Showing Nutrients Consumed and Execreted in Grams with Peroentages Digested.

Seventh Experiment, Timothy Hay and Cotton-seed Meal, 1 to 1.

SHEEP NO. 1.

No. of Analysis.		Total Amount.	Total Dry Matter.	DRY MATTER CONTAINS					
				Ash.	Protein (N×6.25).	Albuminoids (Alb. N × 6.25).	Fat (Ether Extract).	N-free Extract.	Crude Fiber.
677	Timothy hay fed	5103.	4547.8	207.38	272.41	239.21	97.32	2400.78	1569.90
660	Cotton-seed meal fed	5103.	4604.9	319.12	2200.68	2172.13	482.59	1349.24	253.27
	Total fed	10206.	9152.7	526.50	2473.09	2411.34	579.91	3750.02	1822.17
700	Waste timothy hay..	247.0	229.3	12.61	36.34	31.60	7.89	95.09	77.37
699	Waste cotton-seed meal	109.0	101.7	8.01	50.98	46.85	10.42	23.19	9.09
	Total waste	356.0	331.0	20.62	87.32	78.45	18.31	118.28	86.46
	Total consumed	9850.	8821.7	505.88	2385.77	2332.89	561.60	3631.74	1736.71
697	Total solid excrement	9601.5	3286.1	363.11	573.10	482.73	59.81	1020.33	1269.75
	Total digested	.....	5535.6	142.77	1812.67	1850.16	501.79	2611.41	466.96
	Per cent. digested	.....	62.75	28.22	75.98	79 31	89.35	71.91	26.89

Nutritive ratio of ration, 1: 2.39.

SHEEP NO. 2.

677	Timothy hay fed	5103.	4547.8	207.38	272.41	239.21	97.32	2400.78	1569.90
660	Cotton-seed meal fed	5103.	4604.9	319.12	2200 68	2172.13	482.59	1349.24	253.27
	Total fed	10206.	9152.7	526.50	2473.09	2411.34	579.91	3750.02	1823.17
701	Waste	37.	29.5	3.16	12.92	11.81	2.33	7.12	3.97
	Total consumed	.....	9123.2	523.34	2460.17	2399.53	577.58	3742.90	1819.20
698	Total solid excrement	10658.0	3644.1	384.09	609.29	504.34	70.33	1284.91	1295.48
	Total digested	.....	5479.1	139.25	1850.88	1895.19	507.25	2457.99	523.72
	Per cent. digested	.....	60.06	26.61	75.23	78.98	87.82	65.67	28.79
	Average per cent. digested by two animals	.....	61.4	27.4	75.6	79.2	89.	68.8	27.8

Nutritive ratio of ration, 1: 2.3; Mean nutritive ratio of ration, 1: 2.34.

TABLE IX.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

(Eighth Experiment, Second lot of Timothy Hay alone).

SHEEP NO. 1.

No of Analysis.		Total Amount.	Total Dry Matter.	DRY MATTER CONTAINS					
				Ash.	Protein (N × 6.15).	Albuminoids (Alb. N × 6.25).	Fat.	N-free Extract.	Crude Fiber.
677	Timothy hay fed	10206.	9095.6	414.76	544.83	478.43	194.65	4801.57	3139.80
704	Waste	1905.	1630 9	78.28	106.01	96.55	36.37	723.96	686.28
	Total consumed	8301.	7464.7	336.48	438.82	381.88	158.28	4077.61	2453 52
702	Total solid excrement	9564 5	3132.9	225.26	266.92	221.18	74.25	1261.93	1304.54
	Total digested		4331.8	111.22	171.90	160.70	84.03	2815.68	1148.98
	Per cent. digested		58.03	33.05	39.17	42.08	53.09	69.05	46.83

Nutritive ratio 1: 24.3.

SHEEP NO. 2.

677	Timothy hay fed	10206.	9095.6	414.76	544 83	478.43	194.65	4801.57	3139.80
705	Waste	643.	563.9	26.22	32.59	28.93	19.68	254.54	230.86
	Total consumed		8531.7	388.54	512.24	449.50	174.97	4547.03	2908.94
703	Total solid excrement	16079.5	4237.0	293.62	353.79	315.23	95.76	1678.70	1815.13
	Total digested		4294.7	94.92	158.45	134.27	79.21	2868.33	1092.81
	Per cent. digested		50.34	24.43	30.93	29.87	45.27	63.08	37.60
	Average per cent. digested, mean of two animals		54.2	28.7	35.1	36.	49.2	66.1	42.2

Nutritive ratio 1: 26. Mean nutritive ratio 1: 25.3.

TABLE X.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

SHEEP NO. 1—TENTH EXPERIMENT.

No. of Analysis.	CRAB-GRASS HAY ALONE.	Total Amount.	Total Dry Matter.	DRY MATTER CONTAINS. Ash.	Protein (N×6.25).	Albumin'ds (Alb. N ×6.25).	Fat (Ether Extract.)	N-Free Extract.	Crude Fiber.
	Crab-grass hay fed	9072.0	7890.8	505.80	394.54	318.00	172.02	3584.00	3234.44
708	Waste crab-grass hay	3039.	2689.3	151.41	168.35	150.60	69.38	1261.28	1038.88
	Total consumed		5201.5	354.39	226.19	167.40	102.64	2322.72	2195 56
706	Total solid excrement	7467.5	2421.1	203.37	243.56	205.79	59.32	1118.79	796.06
	Total digested		2780.4	151.02	17.37	.....	43.32	1203 93	1399.50
	Per cent. digested	.....	53.45	42.62	.....	.....	42.21	51.83	63.74

SHEEP NO. 2.

	Crab-grass hay fed	10206.	8877.2	569.03	443.86	357.75	193.52	4032.02	3638.76
709	Waste crab-gras hay	3574.	3176.8	158.84	163.92	142.00	68.94	1472.45	1312.65
	Total consumed		5700.4	410.19	279.94	215.75	124.58	2559.57	2326 11
707	Total solid excrement	14694.5	2768.8	251.96	278.54	250.85	68.11	1225.19	944.99
	Total digested		2931.6	158.23	1.40	....	56.47	1334.38	1381.12
	Per cent. digested	.....	51.43	38.57	00.50	.....	45.33	52.13	59.37

TABLE X—Continued.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

SHEEP NO. 3.

No. of Analysis.	CRAB-GRASS HAY ALONE.	Total Amount.	Total Dry Matter.	DRY MATTER CONTAINS. Ash.	Protein (N×6.25).	Albumin'ds (Alb. N ×6.25).	Fat (Ether Extract.)	N-Free Extract.	Crude Fiber.
	Crab-grass hay fed	6577.2	5720.8	366.70	286.04	230.55	124.71	2598.39	2344.96
712	Waste crab-grass hay	1545.0	1353.6	64.30	61.05	50.76	26.94	644.99	556.33
	Total consumed	.....	4367.2	302.40	224.99	179.79	97.77	1953.40	1788.63
710	Total solid excrement	6278.5	2294.4	161.07	209.48	187.91	49.10	983.84	890.92
	Total digested	.....	2072.8	141.33	15.51	.....	48.67	969.56	897.71
	Per cent. digested	..	47.46	46.73	6.89	..	49.78	49.63	50.19

SHEEP NO. 4

	Crab-grass hay	7030.8	6115.4	392.00	305.77	246.45	133.32	2777.61	2506.70
713	Waste crab-grass hay	4380.	3898.8	232.76	245.23	212.09	96.30	1728.73	1595.78
	Total consumed	.....	2216.6	159.24	60.54	34.36	37.02	1048.88	910.92
711	Total solid excrement	2847.	1102.5	80.04	113.34	105.40	24.81	520.82	363.49
	Total digested	.....	1114.1	79.20	52.80	.....	12.21	528.06	547.43
	Per cent. digested	.....	50.26	49.74	.....	.....	32.98	50.35	60.10
	Average per cent. digested, mean of four animals.	.....	50.7	44.4	...	...	42.6	51.	58.4

Mean nutritive ratio, 1: 99.5.

SHEEP No. 1.—Second Experiment.

No. of Analysis.		Total Amount.	Dry Matter.	DRY MATTER CONTAINS. Ash.	Protein.	Albumin'ds (Alb. N ×6.25).	Fat.	N—Free Extract.	Crude Fiber.
656	Timothy hay fed	10206.	9251.7	357.12	523.65	408.93	195.21	5173.55	3002.18
671	Waste timothy hay	624.	528.5	40.96	40.06	29.91	10.94	256.27	180.27
	Timothy hay consumed	9582.	8723.2	316.16	483.59	379.02	184.27	4917.28	2821.91
660	Cotton-seed meal consumed	637.9	575.6	39.89	275.08	271.51	60.32	168.65	31.66
	Total consumed		9298.8	356.05	758.67	650.53	244.59	5085.93	2853.57
669	Total solid excrement	13270.	3994.3	254.44	360.29	321.94	124.62	1884.51	1370.44
	Total digested		5304.5	101.61	398.38	328.59	119.97	3201.42	1483.13
	Digested from cotton seed meal*		421.9	12.57	241.52	236.49	54.11	103.72	14.69
	Digested from timothy hay		4882.6	89.04	156.86	92.10	65.86	3097.70	1468.44
	Per cent. digested from timothy hay		55.97	28.16	32.44	24.30	35.74	63.0	52.04

SHEEP No. 2.

	Timothy hay fed	10206.	9251.7	357.12	523.65	408.93	195.21	5173.55	3002.18
	Waste timothy hay	1726.	1495.6	71.94	88.39	85.55	33.35	785.19	516.73
	Timothy hay consumed	8480.	7756.1	285.18	435.26	323.38	161.86	4388.36	2485.45
	Cotton seed meal consumed	637.	576.6	39.89	275.08	291.51	60.32	168.65	31.66
	Total consumed	9117.	8332.7	325.07	710.34	594.89	222.18	4557.01	2517.11
	Total solid excrement	14058.5	3867.5	269.56	363.16	330.28	108.68	1763.19	1362.91
	Total digested		4465.2	55.51	347.18	264.61	113.50	2793.82	1154.20
	Digestd from cotton seed-meal*		421.9	12.57	241.52	236.49	54.11	103.72	14.69
	Digested from timothy hay		4043.3	42.94	105.66	28.12	59.39	2690.10	1139.51
	Per cent. digested from timothy hay		52.13	16.63	24.28	8.70	36.69	61.30	45.84
	Average per cent. for both animals†		54.1	22.4	28.4	16.5	36.2	62.2	48.9

*Coefficients from B. 97, page 116. †Ratio 1: 33.2

SHEEP NO. 1.—THIRD EXPERIMENT.

No. of Analysis.		Total Amount.	Dry Matter.	DRY MATTER CONTAINS. Ash.	Protein.	Albuminoids (Alb. N × 6.25).	Fat.	N—Free Extract.	Crude Fiber.
677	Timothy hay fed	9355.5	8337.6	380.19	499.42	438.56	178.42	4401.42	2878.14
675	Waste timothy hay	82.	67.6	3.68	6.80	5.94	1.75	33.31	22.06
	Timothy hay consumed	9273.5	8270.0	376.51	492.62	432.62	176.67	4368.11	2856.08
	Cotton-seed meal consumed	779.6	703.5	48.75	336.20	331.84	73.73	206.13	38.69
	Total consumed	10053.1	8973.5	425.26	828.82	764.46	250.40	4574 24	2894.77
	Total solid excrement	12541.0	3885.3	294.89	346.57	315.10	88.20	1737.89	1417.75
	Total digested		5088.2	130.37	482.25	449.36	162.20	2836.35	1477.02
	Digested from cotton-seed meal*		515.7	15.36	295.18	289.03	66.14	126.77	17.95
	Digested from timothy hay		4572.5	115.01	187.07	160.33	96.06	2709.58	1459 07
	Per cent. digested from timothy hay		55.29	30.55	37.97	13.95	54.37	62.03	51.09

SHEEP NO. 2.

677	Timothy hay fed	9355.5	8337.6	380.19	499.42	438.56	178.42	4401.42	2878.14
676	Waste, timothy hay	100.	85.5	4.20	6.61	5.41	1.70	43.16	29.77
	Timothy hay consumed	9255.5	8252.1	375.99	492.81	433.15	176.72	4358.26	2848.37
	Cotton-seed meal consumed	779.6	703.5	48.75	336.20	331.84	73.73	206.13	38.69
	Total consumed	10035.1	8955.6	424.74	829.01	764.99	250.45	4564.39	2887.06
	Total solid excrement	18615.	4429.2	374.71	400.84	363.19	91.68	1925.82	1636.15
	Total digested		4526.4	50.03	428.17	401.80	158.77	2638.57	1250.91
	Digested from cotton-seed meal*		515.7	15.36	295.18	289.03	66.14	126.77	17.95
	Digested from timothy hay		4010.7	34.67	132.99	112.77	92.63	2511.80	1232.96
	Per cent. digested from timothy hay		48.60	9.32	26.99	26.03	52.42	57.63	43.29
	Mean per cent. digested from timothy hay by two animals		52.	19.9	32.5		53.4	59.8	47 2

*Coefficients from B. 97, page 116. Ratio 1:26.3.

SHEEP NO. 1.—FOURTH EXPERIMENT.

No. of Analysis.		Total Amount.	Dry Matter.	DRY MATTER CONTAINS					
				Ash.	Protein.	Albuminoids (Alb. N ×6.25).	Fat.	N—Free Extract.	Crude Fiber.
677	Timothy hay fed	9072.0	8085.0	368.68	484.29	425.27	173.02	4268.07	2790.94
678	Waste, calculated as timothy hay	72.0	57.4	5.45	10.23	6.66	1.99	24.13	15.61
	Timothy hay consumed	9000.0	8027.6	363.23	474.06	418.61	171.03	4243.94	2775.33
660	Cotton-seed meal consumed	1134.0	1023.3	70.91	489.04	482.69	107.24	299.83	56.28
	Total consumed	10134.0	9050.9	434.14	963.10	901.30	278.27	4543.77	2831.61
680	Total solid excrement	15911.5	4465.0	375.95	422.84	371.04	104.93	1968.17	1593.11
	Total digested		4585.9	58.19	540.26	530.26	173.34	2575.60	1238.50
	Digested from cotton-seed meal*		750.1	22.34	429.38	420.42	96.19	184.40	26.11
	Digested from timothy hay		3835.8	35.85	110.88	109.84	77.15	2391.20	1212.39
	Per cent. digested from timothy hay		47.78	9.87	23 39	26.24	45.11	56.34	43.68

SHEEP NO. 2.

677	Timothy hay fed	9072.	8085.0	368.68	484.29	425.27	173.02	4268.07	2790.94
679	Waste, calculated as timothy hay	236.5	208.5	11.47	16.68	13.68	5.15	105.36	69.85
	Timothy hay consumed		7876.5	357.21	467.61	411.59	167.87	4162.71	2721.09
660	Cotton-seed meal consumed	1134.0	1023.3	70.91	489.4	482.69	107.24	299.83	56.28
	Total consumed		8899.8	428 12	956.65	894.28	275.11	4462.54	2777.37
681	Total solid excrement	21206.	4075.3	396.66	442.30	376.42	108.22	2084.45	1673.68
	Total digested		4194.5	31.46	514.35	517.84	166.89	2378.09	1103.69
	Digested from cotton-seed meal*		750.1	22.34	429.38	420.42	96.19	184.40	26.11
	Digested from timothy hay		3444.4	9.12	84.97	97.42	70.70	2193.69	1077.58
	Per cent. digested from timothy hay		43.73	2.55	18.17	23.67	42.12	52.70	39.60
	Mean per cent. digested from timothy hay by two animals		45.8	6.2	20.8	25.0	43.6	54.5	41.6

*Coefficients from B. 97, page 116.

SHEEP No. 1.—FIFTH EXPERIMENT.

No. of Analysis.		Total Amount.	Dry Matter.	DRY MATTER CONTAINS					
				Ash.	Protein.	Albuminoids (Alb. N ×6.25).	Fat.	N-Free Extract.	Crude Fiber.
677	Timothy hay fed	7371.	6569.0	299.55	393.48	345.53	140.58	3467.78	2267.62
660	Cotton-seed meal fed	1842.8	1662.9	115.24	794.70	784.39	174.27	487.23	91.46
685	Waste, (manger scrapings) calculated as cotton-seed meal	33.	24.5	5.97	7.66	6.98	1.69	6.53	2.66
	Consumed from cotton-seed meal	.....	1638.4	109.27	787.04	777.41	172.58	480.70	88.80
	Total consumed	.....	8207.4	408.82	1180.52	1122.94	313.16	3948.48	2356.42
683	Total solid excrement	.....	3974.4	421.29	474.54	410.16	65.18	1671.24	1342 15
	Total digested	.....	4233.0	12.47	705.98	712.78	247.98	2277.24	1014.27
	Digested from cotton-seed meal*	.....	1200.9	34 42	691.02	677.12	154.80	295 63	41.20
	Digested from timothy hay	.....	3032.1	.....	14.96	35.66	93.18	1981.61	973.07
	Per cent. digested from timothy hay	.....	46.16	.....	3.80	10.32	66.28	57.14	42.91

SHEEP No. 2.

677	Timothy hay fed..	7371.	6569.	299.55	393.48	345.53	140.58	3467.78	2267.62
686	Waste, calculated as timothy hay	402.	3415.	17.01	27.01	25.31	9.05	181.64	106.79
	Timothy hay consumed	.....	6227.5	282.54	366.47	320.22	131.53	3286.14	2160.83
660	Cotton-seed meal consumed	1842.8	1662.9	115.24	794 70	784.39	174.27	487.23	91.46
	Total consumed	.....	7890.4	397.78	1161.17	1104.61	305.80	3773.37	2252.29
684	Total solid excrement	18799.	3836.9	375.25	448.53	411.32	90.93	1625.31	1296.87
	Total digested	.....	4053.5	22.53	712.64	693.29	214.87	2148.06	955.42
	Digested from cotton-seed meal *	.....	1218.9	36.30	697.75	683.20	156.32	299.65	42.44
	Digested from timothy hay	.....	2834.6	13.77	14.89	10.09	58.55	1848.41	912.98
	Per cent. digested from timothy hay	.....	45.52	.....	4.06	3.15	44.51	56.25	42.25
	Mean per cent. digested from timothy hay by two animals	.....	45 8	.....	3.9	6.7	55.4	56.7	42.6

*Coefficients from B. 97, page 116.

Sheep No. 1.—Sixth Experiment.

No. of Analysis.		Total Amount.	Dry Matter.	DRY MATTER CONTAINS					
				Ash.	Protein.	Albuminoids (Alb. N ×6.25).	Fat.	N-Free. Extract.	Crude Fiber.
677	Timothy hay fed and eaten	5670.	5053.1	230.42	302.68	265.79	108.14	2667.53	1744.33
660	Cotton-seed meal fed	2835.	2558.3	177.29	1222.61	1206.75	268.11	749.58	140.71
689	Waste, calculated as cotton-seed meal	34.5	27.6	3.06	9.88	8.95	2.24	8.57	3.86
	Consumed from cotton-seed meal	.....	2530.7	174.23	1212.73	1197.80	265.87	741.01	136.85
	Total consumed	.....	7583.8	404.65	1515.41	1463.59	374.01	3408.54	1881.18
687	Total solid excrement	10377.5	2887.0	319.30	412.26*	368.09	55.14	1050.87	1049.42
	Total digested	.....	4696.8	85.35	1103.15	1095.50	318.87	2357.67	831.76
	Digested from cotton-seed meal*	.....	1855.0	54.88	1064.78	1043.28	238.49	455.72	63.50
	Digested from timothy hay	.....	2841.8	30.47	38.37	52.22	80.38	1901.95	768.26
	Per cent. digested from timothy hay	.....	56.24	13.22	12.68	19.65	74.33	71.30	44.04

Sheep No. 2.

677	Timothy hay fed	5670.	5053.1	230.42	302.68	265.79	108.14	2667.53	1744.33
660	Cotton-seed meal fed	2835.	2558.3	177.29	1222.61	1206.75	268.11	749.58	140.71
690	Waste, cotton-seed meal	26.5	24.0	2.64	9.00	8.16	2.01	7.32	3.03
	Consumed from cotton-seed meal		2534.3	174.65	1213.61	1198.59	266.10	742.26	137.68
	Total consumed		7587.4	405.07	1516.29	1464.38	374.24	3409.79	1882.01
688	Total solid excrement	14934.5	3318.0	371.62	454.23	396.17	58.07	1204.77	1229.32
	Total digested		4269.4	33.45	1062.06	1068.21	316.17	2205.02	652.69
	Digested from cotton-seed meal*		1857.6	55.01	1065.55	1043.97	238.69	456.49	63.88
	Digested from timothy hay		2411.8			24.24	77.48	1748.73	588.81
	Per cent. digested from timothy hay		47.73			9.12	71.65	65.55	33.76
	Mean per cent. digested by two animals		52.0	†13.2	†12.7	14.4	73.0	68.4	38.9

*Coefficients from B. 97, page 116. †Sheep No. 1 only.

No. of Analysis.		Total Amount.	Dry Matter.	DRY MATTER CONTAINS					
				Ash.	Protein.	Albuminoids (Alb. N ×6.25).	Fat.	N-Free Extract.	Crude Fiber.
677	Timothy hay fed	5103.0	4547.8	207.38	272.41	239.91	97.32	2400.78	1569.90
700	Waste, timothy hay	247.0	229.3	12.61	36.34	31.60	7.89	95.09	77.37
	Consumed in timothy hay		4318.5	194.77	236.07	207.61	89.43	2305.69	1492.53
660	Cotton-seed meal fed	5103.	4604.9	319.12	2200.68	2172.13	482.59	1349.24	253.27
669	Waste, cotton-seed meal	109.	101.7	8.01	50.98	46.85	10.42	23.19	9.09
	Consumed in cotton-seed meal		4503.2	311.11	2149.70	2125.28	472 17	1326.05	244.18
	Total consumed		8821.7	505.88	2385.77	2332.89	561.60	3631.74	1736.71
697	Total solid excrement	9601.5	3286.1	363.11	573.10	482.73	59.81	1020.33	1269.75
	Total digested		5535.6	142.77	1812.67	1850.16	501.79	2611.41	466.96
	Digested from cotton-seed meal*		3300.8	98.00	1877.44	1851.12	423.54	815.52	113.33
	Digested from timothy hay		2234.85	44.77			78.25	1795.89	353.63
	Per cent. digested from timothy hay.		51.7	22.99			87.50	77.89	23.69

*Coefficients from B. 97, page 116.

SHEEP NO. 2.

677	Timothy hay fed	5103.0	4547.8	207.38	272.41	239.21	97.32	2400.78	1569.90
660	Cotton-seed meal fed	5103.0	4604.9	319.12	2200.68	2172.13	482.59	1349.24	253.27
701	Waste, cotton-seed meal	37.0	29.5	3.16	12.92	11 81	2.33	7.12	3.97
	Consumed in cotton-seed meal	.....	4575.4	315.96	2187.76	2160.32	480.26	1342.12	249.30
	Total consumed	.....	9123.2	523.34	2460.17	2399.53	577.58	3742.90	1819.20
698	Total solid excrement	10658.	3644.1	384.09	609.29	504.34	70.33	1284.91	1295.48
	Total digested	.....	5479.1	138.25	1750.88	1895.19	507.25	2457.99	523 72
	Digested from cotton-seed meal*	.....	3353.8	99.53	1920.85	1881 64	430.79	825.40	115.68
	Digested from timothy hay	.....	2125.3	38.72	.....	13.55	76.46	1632.59	408.04
	Per cent. digested from second lot timothy hay.	.....	46.73	18.67	.....	5.66	78.57	68.00	25.99
	Mean per cent. digested from timothy hay by two animals	.....	49.24	20.83	.....	.....	83.03	72.95	24.84

*Coefficients from B. 97, page 116.

PASTEURIZATION OF MILK.

BY FRANK E. EMERY.

To Pasteurize is to practice after Pasteur, or to follow a method or practice of his in freeing some substances of germs—minute vegetable forms, which can only be seen by using a microscope of high power. Then Pasteurization is the act of killing germs according to the practice of Pasteur.

The original practice has been improved upon until it can be relied on implicitly to kill all active germs, and if need be to continue for a longer time, and repeat after standing some hours, or days, to sterilize or destroy all germs which may have been in a resting stage at the first operation.

Germs of some kinds are necessary to all our operations in the dairy. We cannot do without them, and would not if we could; but they are like everything else—composed of good, bad and indifferent. If the indifferent or bad germs get the upper hand in our operations, as sometimes happens in hot weather, losses occur. Even the good or friendly forms must be kept within control to a certain extent, in order that the products of our dairies shall acquire that uniformity of qualities which commends them to our customers.

Some people who lead off in new fashions go so far as to Pasteurize out the germs in their milk and put in others, which have been specially prepared, and are more or less pure in regard to the single or few species desired to give a certain desired flavor. This is for butter-mak ng. No one has yet attempted to isolate and prepare colonies of germs which can give a given flavor in cheese, because the number of kinds which may be concerned in giving a first-class kind of cheese is as yet practically unknown.

But it is to rid ourselves of the bad germs that Pasteurization is most often introduced.

Most of the disease-producing germs, when introduced in some accidental way into milk find it a rich soil in which to multiply. Some others can live, and be transferred in it to the human system, where they can reproduce disease. Among these the cholera germ has been known to have been the cause of death from dilution with contaminated water. Had the milk soured before being used, the cholera germ would have been killed by the acid given out by one of the good forms.

Similarly the germ of consumption may gain access to milk from a cow, or from her attendant, or possibly from dust by careless handling. If this milk cools below 86° F. this germ cannot

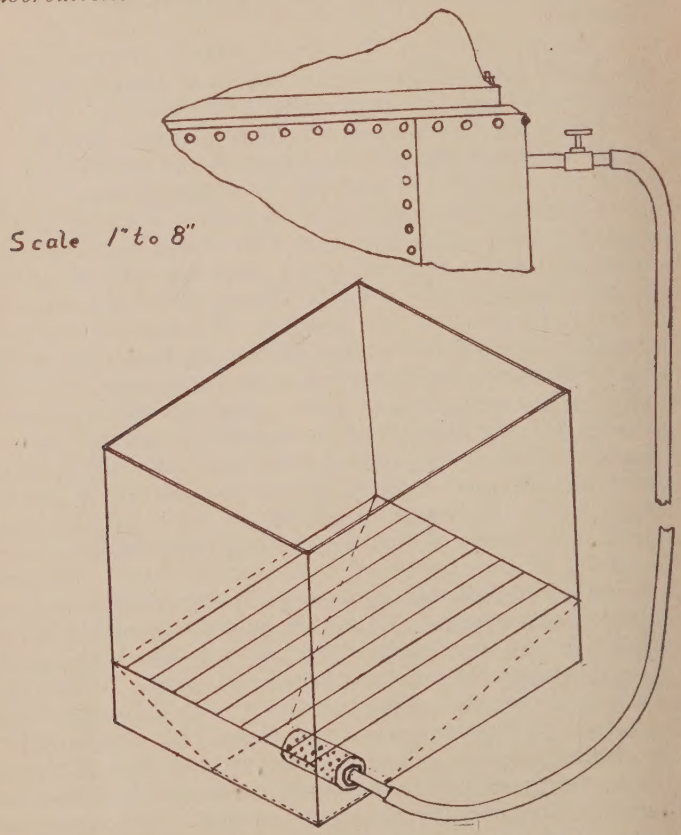
grow, but would be held alive and in readiness to grow and produce disease whenever a chance presents itself to do so. If, now, this milk is suspected, and is subjected to pasteurization, it will be killed, and no disease will be produced where it had not already been implanted.

There is another phase of the subject, which has been pointed out by Dr. James Law, of Cornell University, in New York, which has not been recognized by other authorities generally. This is a danger of hastening the disease which may have already been started in the tissues of the body of a user of the animal food products which may contain the chemical principle, tuberculin.

The germ, bacillus tuberculosis, in its growth liberates a chemical poison *tuberculin*. It is probable that death by consumption results from progressive slow poisoning from the effect of this substance, in part, as well as by the interference of foreign organisms with the bodily functions of the victims. If the above mentioned idea that tuberculin may hasten the disease be true, then no Pasteurized product which really needed to be Pasteurized will do for consumptives; but it may not be true. Analogy would deny this, because the germ bacterium lactici acidi becomes inactive when .8 of one per cent. of its waste product, lactic acid, has been produced, and animal organisms are asphyxiated in the air, which becomes overcharged with the waste products of their life functions. Therefore Koch's theory of a cure by adding tuberculin to the system of a victim of the disease of consumption would seem to be correct, according to those other phases of Nature's means of checking production of a species. If only the animal organism can bear, and become tolerant of, enough of the poison to check the growth of the germ, consumption can be arrested and cured. Who will be the first to search out and announce the way to accomplish this?

But to return to Pasteurization and close. By searching for a means to check growth of germs M. Pasteur heated his substances up to different degrees, and found some forms would be destroyed and others left alive at different degrees of heat. It has now been learned that if heat enough is applied to destroy bacillus tuberculosis, most other forms, and perhaps all other common bad forms, will also have been destroyed. Pasteur's process then means to heat up a substance to, and a little above, the thermal death point of the species to be destroyed, and if the point needed to kill B. tuberculosis is reached nearly all, if not all, other bad germs will have perished. Various experimenters have heated up media containing these germs to different degrees and have then examined with the microscope to find what is the thermal death point of this dreaded germ. It has been found that two factors control this point—the time during which the heat is raised to a given point and the height of the heat attained. Thus, to give some of these

points, and the time required, we may begin with a low degree, and give the long time required first. Then pass to higher degrees and shorter times, which have been found sufficient to destroy *B. tuberculosis*.



Forster (Milch Zeitung, 1894, p. 84), quoted in "The Principles of Modern Dairy Practice," p. 158, found:

131° F.	continued	4	hours	sufficed,	or
140° F.	"	1	"	"	or
158° F.	"	10	min.	"	or
170° F.	"	5	"	"	or
203° F.	"	1	"	"	
Bitter (*Ibid*) found 154° F.	"	30	"	"	

Dr. Law, Cornell Bulletin 65, gives Yersin as authority for a temperature of 158° F. for ten minutes.

Russel (Outlines of Dairy Bacteriology) gives the following:

140° F.	for 10	minutes	kills most forms.
149° F.	for 30	"	" B. tuberculosis.
155° F.	for 15	"	" B. tuberculosis.
167° F.	for 10	"	" B. tuberculosis.

In treating milk it must be borne in mind that milk assumes a cooked taste if heated much above 160° F., hence it is desirable to raise it to some of the lower temperatures for a long enough time and not risk changing its flavor, as it then becomes objectionable to many consumers.

This heating, or pasteurization, of milk is therefore indicated for suspicious samples before using it for human or animal food, since our domestic animals are as subject to the disease produced by this germ as are human beings. Everyone may not have need of using this method of clearing milk of dangerous germs, but it is a useful bit of knowledge to know how to use it, if unhappily it be needed. At the Experiment Farm, in 1893, a cow was suspected of being a victim of disease, and a piece of apparatus was devised in which to Pasteurize the milk. Recently it has been brought out, and a cut has been prepared to accompany these notes. A large galvanized iron can, with bottom sloping two ways to near one corner, where a steam muffle is put in, and the rubber pipe pushed on over the piece of pipe left projecting at the side. At the ends a shoulder supports an iron-rod rack, on which the glass jars, or tin cans, containing the milk to be heated, rests. The rubber hose is attached to the steam boiler, and live steam applied as desired. The large can can also be set on a stove and used in the same way, but whichever way it is used, an accurate thermometer is needed to be frequently used to see that the heat is kept up as desired, and that too high a temperature is not generated in the milk.

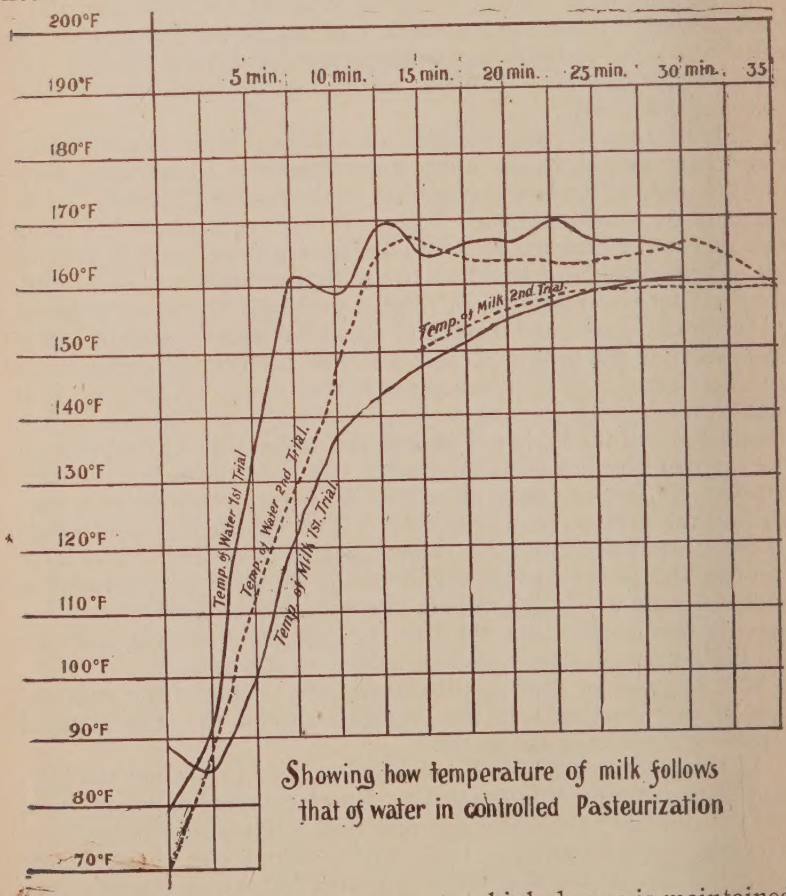
The diagram on page 305 illustrates the raising of the temperature in water and milk in the Pasteurizing can, the milk being of greater volume than the water.

Additions of steam can be nicely regulated to prevent too high heat in the water. The black line represents temperature of milk, and the red line* the water for one trial. The broken black and red lines represent another trial, during which the changes were not noted during the first fifteen minutes, but which shows a very steady temperature of 158 to 9° F. for 10 minutes to 15 minutes above 155° F., and 20 minutes above 150° F., after which it was allowed to cool rather slowly.

A cooler has been devised, but had not been made when our milk supply was cut off, and we have not been in need of one much since. The cooler we have made consists of a coil of pipe through a cooley

*For convenience in printing, only one color is used, and the different lines are indicated by words following each line.

milk can. The milk is drawn through this coil fast or slow, according to need from a faucet in the Pasteurizing can. The cooley can is to be filled with cold water, or water and finely broken ice, or possibly cold brine. The cooley can is large enough to serve our purpose. On a larger scale vessels of ampler proportions will be needed.



Showing how temperature of milk follows that of water in controlled Pasteurization

When the required temperature at a high degree is maintained for the given time the requirement for several of the lower temperatures has been fulfilled.

The practice of Pasteurizing is somewhat troublesome, but it is a safeguard which can be easily invoked by anyone to guard against a suspicious food product, be it milk, meat, or some other article; the same degree of heat for the same length of time will free it from germs which might produce disease.